



## " K32 -P2"

K32 is a product specifically designed to provide an agricultural benefit to farmers while reducing the ecological impact of surface applied urea-containing products. The agronomic benefit of using urease inhibitors is well-documented in the peer-reviewed literature. One of the benefits to farmers of urease inhibitors is the achievement of a higher production yield per acre. If growers practice proper nutrient management, farmers are expected to benefit from a reduced amount of nutrient inputs needed for an equivalent yield compared to conventional fertilizer applications. In many cases, with proper nutrient management, farmers are expected to experience a combination of both higher yield and lower nutrient inputs.

K32 is a novel urease inhibitor that reduces the environmental impact caused by the use of agricultural fertilizers without introducing additional risks from adjuvants. K32 reduces ammonia emissions that typically occur after surface application of urea-containing fertilizers. This emission loss negatively affects crop productivity and profitability of a farming enterprise and it contributes to air and water pollution. Ammonia gas from agricultural activities combines with other atmospheric components to form air particulates which are partially responsible for reduced visibility and possible breathing difficulties. Ammonia emissions also contribute to the redistribution of nitrogen in the environment; the ammonia may be redeposited on ecologically sensitive tracts that are spatially separated from the original application area or deposited in surface waters where the ammonia can contribute to eutrophication. Urease inhibitors are important tools in the effort reduce nutrient loss and preserving air and water quality. The American Association of Plant Control Officials (AAPFCO) currently defines urease inhibitors as substances which inhibit hydrolytic action on urea by the enzyme urease.

When applied to soil surfaces, urea rapidly begins to hydrolyze due to the action of naturally occurring urease, a ubiquitous enzyme present in all soils. The products of this hydrolysis are ammonia and carbon dioxide ( $\text{CO}_2$ ), which are rapidly lost to the environment through air emissions. Nitrogen losses in such situations are typically 20-30% but may reach excesses of 70% (Kiss and Simhaian 2002).

AAPFCO also defines any fertilizer that contains a urease inhibitor as an Enhanced Efficiency Fertilizer (EEF). EEFs are fertilizer products with characteristics that allow increased nutrient availability and reduce potential nutrient losses to the environment (e.g., gaseous losses, leaching or runoff when compared to an appropriate reference product). EEFs are used as alternatives or complements to conventional fertilizers for their numerous agronomic, economic and environmental benefits (Thapa et al., 2016). The primary commercial urease inhibitor is *N*-(*n*-butyl thiophosphoric triamide (NBPT). NBPT has been available prior to 1992 and is marketed by the applicant under the AGROTAIN® trade name. NBPT is added to urea-fertilizers at about 0.065% and is quite effective at reducing urea hydrolysis. Unfortunately, NBPT is effective for a relatively short period of time. Once it is in contact with the soil it degrades through oxidation and hydrolysis (Engel 2015). If there a significant time lapse between fertilizer application and rainfall, NBPT may no longer be effective because of its degradation and half-



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life. As a result, NBPT may not be present when the urea is subject to hydrolysis by urease (a process that requires water).

### Improved Urease Inhibition

To improve upon the efficiency of NBPT, Koch Agronomic Services researched ways to prolong the half-life, to ensure that NBPT is present in the soil when needed, to prevent the hydrolysis of urea. KAS discovered that it could combine NBPT with formaldehyde and urea in a reaction product mixture. The resultant adducts, typically adducts between formaldehyde and 1 or 2 equivalents of NBPT and urea, are the ingredients of K32 that provide urease inhibition. The K32 adducts are stable enough to extend the availability of NBPT, while being labile enough that NBPT is released when water is present, ensuring that a low level of NBPT is present for the days or weeks during which the urea fertilizer is taken up by the crop. K32 is a significant improvement over NBPT and other urease inhibitors currently on the market. Using K32 in place of NBPT broadens the array of fertilizers that qualify as EEFs and can play a part in reducing impacts to air and water that result from the enzymatic hydrolysis of urea.

Laboratory and field trials using K32 have repeatedly shown the potential to increase yield and to preserve nutrients by inhibiting the degradation of urea and the associated volatilization of ammonia. K32 outperforms the current urease inhibitor products on the market. Particularly in acidic soils, K32 demonstrates benefits above those of NBPT alone, as NBPT is particularly susceptible to abiotic chemical degradation and mineralization in acidic soils.

### Environmental Performance and Potential

By reducing the amount urea converted to ammonia, K32 significantly reduces the amount of nitrogen needed to achieve the intended agronomic benefit and reduces ammonia releases to air (and water via redeposition). As shown in Table 1 & 2, research work with multiple university programs has demonstrated that the addition of K32 results in measurable yield increases or improvement in ammonia volatilization.

Table 1: Improvement in crop yield by urease inhibitors\*

|               | NBPT improvement over untreated urea | K32 improvement over NBPT |
|---------------|--------------------------------------|---------------------------|
| Virginia Tech | 34%                                  | 40%                       |

Table 2: Improvement in ammonia volatilization by urease inhibitors\*

|           | NBPT improvement over untreated urea | K32 improvement over NBPT |
|-----------|--------------------------------------|---------------------------|
| Louisiana | 26%                                  | 60%                       |

\*Unpublished data available upon request



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The current estimated amount of urease-inhibitor-treated urea in the United States is 2-3 million tons. Roughly, 800,000 tons of that material has the potential to be lost as ammonia from volatilization. If farmers increase efficiencies through the use of K32, they may be able to recoup 60% of the lost nitrogen, potentially saving 480,000 tons of fertilizer that would otherwise be lost to the environment and potentially impact the quality of air and surface waters.



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## References

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